



**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of : Camacho-Lopez et al.  
For : **MOTION OF LIQUID CRYSTALLINE  
ELASTOMERS AND METHOD OF USE  
THEREOF**  
Serial No. : 10/732,880  
Filed : December 10, 2003  
Group Art Unit : 1756  
Examiner : Wu, Shean Chiu  
Confirmation No. : 6839  
Last Office Action : January 19, 2006  
Attorney Docket No. : KSU.239  
KNST 200018  
Cleveland, Ohio 44114-2518

**DECLARATION UNDER 37 C.F.R. §1.131**

Mail Stop Amendment  
Commissioner for Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

1. We, Miguel Angel Camacho-Lopez, Peter Palffy-Muhoray and Michael J. Shelley, do hereby declare and say that we are the inventors in the above-identified United States patent application, Serial No. 10/732,880.

2. This Declaration is to establish reduction to practice of the

invention in this application in the United States at a date prior to December 10, 2002, which is the effective date of the reference asserted against the above application (the article "Swimming Towards the Dark: A Photophobic light-driven Elastomeric Swimmer" by Camacho-Lopez et al., The First World Congress on Biomimetrics & Artificial Muscles ("Camacho-Lopez")). This Declaration is being submitted prior to a final rejection issuing in the above-identified patent application.

3. To establish conception and reduction to practice of the invention at least prior to December 10, 2002, attached is a redacted copy of an invention record (3 pages) submitted to the Kent State University Office of Technology Transfer and Economic Development (Exhibit A). We hereby declare and say that the relevant portions of Exhibit A predate December 10, 2002, the effective date of the Camacho-Lopez reference.

4. In particular, Exhibit A describes the present invention which relates to the light avoiding motion of liquid crystal elastomers in a fluid. Deformation and subsequent movement of the liquid crystals when subjected to radiation is described.

5. Each date redacted in Exhibit A is at least prior to December 10, 2002, the effective date of the Camacho-Lopez reference.

6. It is submitted that the information attached as Exhibit A clearly demonstrates reduction to practice of the invention in this country at a date at least prior to December 10, 2002.

7. I hereby declare that all statements made herein are of my own knowledge and are true, and that all statements are made on information and belief and are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

  
Miguel Angel Camacho-Lopez

Date: June 2, 2006

\_\_\_\_\_  
Peter Palffy-Muhoray

Date: \_\_\_\_\_

\_\_\_\_\_  
Michael J. Shelley

Date: \_\_\_\_\_

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Miguel Angel Comacho-Lopez

P P (11)  
Peter Palfy-Muhoray

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Michael J. Shelley

Date: \_\_\_\_\_

Date: May 27, 2006

Date: \_\_\_\_\_

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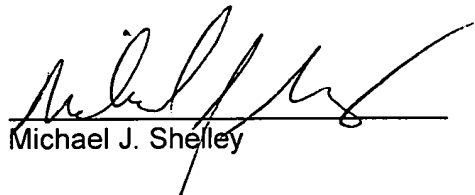


\_\_\_\_\_  
Miguel Angel Comacho-Lopez

Date: \_\_\_\_\_

\_\_\_\_\_  
Peter Palffy-Muhoray

Date: \_\_\_\_\_

  
\_\_\_\_\_  
Michael J. Shelley

Date: May 25, 2006

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## EXHIBIT A

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RETURN TO: Technology Transfer  
Research and Graduate Studies  
1335 Terrace Hall 672-2372

## KENT STATE UNIVERSITY INVENTION DISCLOSURE FORM

Date received  
by OTTOC: \_\_\_\_\_

KENT Log No.  
(OTTOC use only)

239

SEE RELATED INSTRUCTIONS BEFORE COMPLETING

1. TITLE OF INVENTION <b>Light Avoiding Motion of Floating Liquid Crystalline Elastomers</b>		
2. PLEASE ATTACH full description of technology including: (A) General purpose (B) Technical description (C) Improvements over existing methods, devices or materials (D) Commercial applications and contacts interested in this invention		
3. LIST the closest prior art related to this invention. DATABASE SEARCHING IS RECOMMENDED.		
4. INVENTOR(S) - List Principal Investigator FIRST: (1) MIGUEL ANGEL CAMACHO LOPEZ (2) PETER PALFFY - MUHORA (3) HEINO FINKELMANN (4) MICHAEL SHELLEY	POSITION	RESEARCH DEPARTMENT/PHONE LCI, KSU LCI, KSU FREIBURG NYU
5. Was this invention developed with the use of any research grant/contract funds? YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> SPONSOR(S) <b>NSF/Alcom</b> CONTRACT/GRANT NUMBERS <b>89-DMR 20147</b> PRINCIPAL INVESTIGATOR <b>P. Palffy</b>		
6. Were KENT funds or facilities used (as defined in instructions)? YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>		
7. DATES OF CONCEPTION and PUBLIC DISCLOSURE (Accurate data is essential as prior disclosure may affect the possibility of obtaining patent rights.)	DATE	REFERENCES/COMMENTS Please include names of periodicals/journals (Use separate sheet if necessary)
(A) Date of conception of invention. Is documented? Where?	<b>YES</b> (1989)	
(B) First disclosure (oral or written) containing sufficient description to enable a person skilled in this field to understand and make or use the invention. (Include dates, and date submitted)		
(C) If unpublished and undisclosed, provide the anticipated publication or oral disclosure date and any submissions made for potential publication.		
8. Has this invention been reduced to practice? YES <input type="checkbox"/> NO <input type="checkbox"/> If yes, give date first reduced to practice _____		
9. I hereby declare that all statements made herein based upon my own knowledge are true. I further declare that statements made herein which are not based upon my personal knowledge are believed to be true.		
(1) Inventor's Signature <b>Miguel Angel Camacho Lopez</b> PRINTED NAME <b>MIGUEL ANGEL CAMACHO LOPEZ</b> Home Address <b>Modelos No. 714 TERNANCINGO EDO. MEX. C.P. 52400</b> <b>273061960 MEXICAN</b> Social Security No. (Required) <b>MEXICO</b> Country of Citizenship	(2) Inventor's Signature <b>P. Palffy</b> PRINTED NAME <b>P. PALFFY - MUHORA</b> Home Address <b>1866 Brookview Dr. Kent, OH</b> <b>532-60-8913</b> Social Security No. (Required) <b>USA</b> Country of Citizenship	
(3) Inventor's Signature <b>H. Finkelmann</b> PRINTED NAME <b>H. FINKELMANN</b> Home Address <b>BERTHOLDSTR. 4, 79211 DENZLINGEN</b> <b>GERMANY</b> Social Security No. (Required) <b>GERMANY</b> Country of Citizenship	(4) Inventor's Signature <b>Michael J. Shelley</b> PRINTED NAME <b>Michael J. Shelley</b> Home Address <b>110 Blecker St, 30F, NY, NY</b> <b>521-08-2222</b> Social Security No. (Required) <b>USA</b> Country of Citizenship	
10. Disclosed to and understood by (signature): <b>Antal Jakli</b> PRINTED NAME <b>ANTAL JAKLI</b> Date _____		Acting Secretary/Deputy Chair/Director (signature) <b>John H. West</b> PRINTED NAME <b>John H. West</b> Date _____

Invention Disclosure:

**Light Avoiding Motion of Floating Liquid Crystalline Elastomers**

**Description of the Phenomena:**

When a beam of light, from a light source such as a laser, is made to fall on a light absorbing liquid crystal elastomer floating on a fluid such as water, the elastomer moves away from the light.

Our research, which produced this phenomenon, resulted in the discovery of a new way of propelling floating objects.

**Technical description:**

We have studied the behavior of silylene-based nematic elastomers swollen with a the Disperse Red 1 azo-dye when exposed to light. We have discovered that the elastomer samples are expelled from the regions of illuminated with light from an Ar ion laser operating at the wavelength of 524nm. Disk-shaped elastomer samples with thickness of 0.3 mm and diameter of 3mm as well as other shapes were floated on water, and were illuminated. After a short period of time, the elastomer changes shape and bends up at the edges, then moves away from the illuminated region. This behavior was observed for laser intensities of  $0.4 \text{ W/cm}^2$  and greater. We have measured a displacement of 1.2 cm when the laser intensity was  $1.1 \text{ W/cm}^2$ . In this case, the maximum speed of the sample was 1.8cm/s. For circular disks, the sample returns to the original position if the laser light is blocked; for irregular shapes, the sample typically does not return.

When the sample was floated on other fluids (ethylene glycol, mixtures of ethylene glycol and water, salt water) the same phenomenon was observed, but with different displacements and speed.

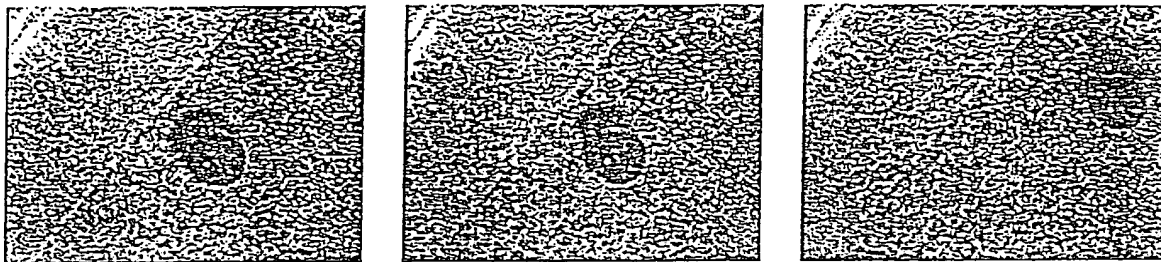
The photographs below show the displacement of the elastomer after irradiation by light from the Ar ion laser. The 3mm dia. sample is floating on water 1cm deep in a 5cm. dia. glass dish.

The first picture (on the left) shows the elastomer when irradiation starts.

The second picture (in the middle), 1.5s later, shows the elastomer bending.

The third picture (on the right) shows the elastomer displaced from the laser beam.

The dark spot is the shadow of the disk-shaped elastomer sample.



Key features of the process is the change in shape of the floating object, and the dependence of this shape on position. Light causes the deformation of the shape of the liquid crystal elastomer, likely by altering its order parameter which couples to mechanical strain, and provides the energy for the motion. A physical model describing fundamental aspects of this behavior has been developed.

#### Advantages and improvements over existing methods:

We are not aware of prior evidence of this phenomenon, or of any processes or devices based on it. It represents a novel method of inducing motion.

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## Commercial Applications

Because of the novelty of this phenomenon, commercial applications have not yet been developed. It is a new method of propulsion for objects and materials floating on fluids or supported on deformable media.

Potential applications can range from a novel propulsion scheme for deformable boats and other objects, and a means of inducing transport of materials and pumping fluids. The realization may involve elastomers and light, but the principle can be applied to a broad range of materials and objects, and may use energy sources other than light.